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Innovation and Clustering: Lessons from the Construction sector and Critical Success Factors for adoption and implementation. Lost cause or lacuna?

Sofia Yfanti[1], David Edgar[2], Bryan Temple[3], Nikos Sakkas[4]
[1]Technical Service of Municipality of Hersonisos, Eleytherias 50, lim., Heraklion, Crete, Greece
[2]Professor of Strategy & Business Transformation, Department of Business Management, Glasgow School for Business and Society, Glasgow Caledonian University, Cowcaddens Road, Glasgow, G4 0BA, Scotland, United Kingdom
[3]Glasgow Caledonian University, Cowcaddens Road, Glasgow, G4 0BA, Scotland, United Kingdom
[4]Professor of Energy and Environmental Management, Department of Mechanical Engineering, Technological Educational Institute of Crete, Heraklion, Crete 71003 Greece
([1]s.ifanti@hersonisos.gr, [2]d.a.edgar@gcu.ac.uk, [3]btbforbach@gmail.com, [4]sakkas@emttu.org)

***Abstract*-** Innovation through clustering has proven to work well in a range of industries and geographic regions. However, significant numbers of clusters fail, especially in the Greek construction industry. It appears that certain critical success factors are required, raising the need for research to better understand how the critical success factors' influence innovation. For this paper an interesting and challenging innovation context is selected, namely the Greek construction sector, that represents a fusion of small organisation size, brutal economic climate and an array of attitudes towards innovation. Through a questionnaire with 92 managers and ten in-depth interviews, the findings indicate that the Greek construction sector is mainly comprised of micro firms and that the perceived CSFs for implementing innovation clusters is significantly different from those identified in the literature. The responses from the firms raise interesting perspectives and questions whether innovation through clustering is a lost cause for micro construction companies.

***Keywords*-** *Innovation, Construction, Cluster, CSF, Greece*

I. INTRODUCTION

According to Eurostat's website there is several action points that place innovation at the heart of the Europe 2020 strategy associated with the future of the construction sector. However, there is little known of the challenges faced by the sector and in particular SMEs. Indeed previous studies have shown that firms are unaware of ways to reformulate traditional frameworks and networks in order to face the current and future challenges (RegCon Project, 2009).

Understanding these challenges and identifying the critical success factors (CSF) allows a greater impact of the Europe 2020 strategy, and lead to a more prosperous economic climate. The increased complexity and connectivity of globalised markets is shaping a new framework for the operation of society (Kiriazoglou, 2005) in the European Union, and within such a demanding framework, construction generates 10% of gross domestic product (GDP) and 20 million jobs (EU Commission, 2015).

The aim of this paper is to investigate the nature and challenges of innovation within the critical success factors (CSFs) that can help firms confront such challenges. The paper explores the nature of innovation before focusing on the need for innovation within the construction sector and the CSF required for improvement. These are identified and a research framework is presented whereby elements are explored within the Greek construction innovation cluster context and micro-companies, and the tremendous political and economic turmoil Greece has suffered in recent years.

II. BACKGROUND

The Greek economy went into recession in 2009 as a result of the world financial crisis, followed by a severe debt crisis in 2010. This led to a bailout agreement with the IMF, the ECB and the European Commission, followed by a stringent austerity program which in turn brought about cuts in public expenditures and investments. These cuts, together with projected tax increases and the persisting impact of the international financial crisis caused, by the end of 2012, a steady decline in GDP per capita from €20,500 in 2009, to €17,200 in 2012 (67.2% of the EU-27 average). According to the latest available statistical data, Greece presented above EU-average growth before the crisis (2007), but has suffered a heavy uninterrupted recession since 2008. Based on the revised data of the Hellenic Statistical Service (El.Stat.) the dramatic deterioration in the Greek economy is officially attributed mainly to the "freezing" of public and private investment, and a contraction of consumer demand. Thus it is evident that now more than ever firms need a new plan that will ensure their survival, a plan that will change things to their interest.

A survey conducted by the University of Manchester, concerning Community policies that impact on the competitiveness of the construction sector, concluded that one of the policy areas that particularly needed further investigation within the construction sector was research and innovation. However, the survey's respondents appeared to be equivocal as regards the participation of SME in such innovation or research programmes (Contract No 30-CE-0043801/00-12, 2006). This was largely due to the cost to the SME, even though the research aim was to support competitiveness and to create a positive impact upon firms, networks of firms and the economy of the European Union.

Construction is recognised as different from other production systems in a number of important aspects:

i. The products are fixed in space, commissioned or made to order for a particular client,

ii. For the completion of the product subcontracting is often a necessity, and

iii. Construction projects take place within a specific socio-political context so the process of innovation is affected and hence differentiated from other sectors.

As such, what is described as innovation for a construction company differs by company and by company context (Phua, 2004). This poses the problem of innovation definition within the sector. Therefore Table 1 below highlights the range of definitions of innovation commonly used in order to narrow down to a definition for innovation related to construction.

TABLE I. RANGE OF DEFINITIONS OF INNOVATION IN CHRONOLOGICAL ORDER (SOURCE: AUTHOR)

A process that begins with an idea, proceeds with the development of an invention, and results in the introduction of a new product, process or service to the market place.	Edwards and Gordon, 1984
The actual use of a nontrivial change and improvement in a process, product, or system that is novel to the institution developing the change.	Hannan and Freeman, 1984
A product, service, or process that is new or perceived as new by its developers. As long as the idea is perceived as new to the people involved, it is an innovation, even though it may appear to others to be an imitation of something that exists elsewhere.	Van de Ven, 1986
Anything new that is actually used.	Slaughter 1993 (as cited in Seaden and Manseau, 2001)
The application of technology that is new to an organization and that significantly improves the design and construction of a living space by decreasing installed cost, increasing installed performance, and/or improving the business processes.	Toole, 1998
A product of organizational learning.	Cayer, 1999
The successful exploitation of new ideas, where ideas are new to a particular enterprise, and are more than just technology related – new ideas can relate to process, market or management.	Seaden and Manseau, 2001
The generation of a new idea and its implementation into a new product, process, or service leading to the dynamic growth of the national economy and the increase of employment as well as the creation of pure profit for the innovative business enterprise.	Barrett and Sexton, 2006
The act of introducing and using new ideas, technologies, products and/or processes aimed at solving problems, viewing things differently, improving efficiency and effectiveness, or enhancing standards of living.	
The capability of continuously achieving a desired future	John Kao, 2007
A new or significantly improved product (good or service) introduced to the market or the introduction within an enterprise of a new or significantly improved process and includes those with ongoing and abandoned activities.	BIS Performance Indicators, 2014

Examining the above definitions and concurring with Barrett and Sexton, (2006) there appears to be an ongoing shift from viewing innovation as an end in itself, to innovation being a means to achieve sustainable competitiveness, viewed as a process that enhances the competitive position of a firm through the implementation of a large spectrum of new ideas. Throughout our study innovation within the construction sector is defined as "any new idea (technology, product or process) that is implemented by the construction firms internally (to their structure) or externally (in a project) aiming to gain in short term benefits and in long term competitiveness".

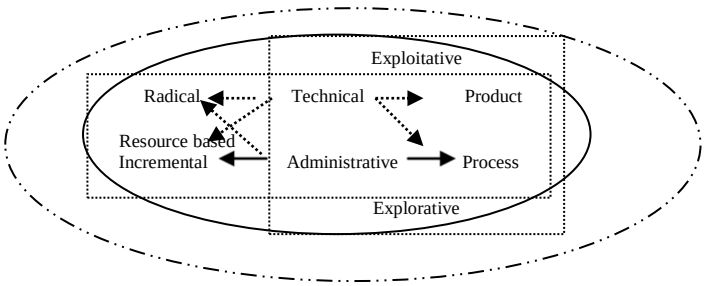
Having determined our definition of innovation, we now explore the different aspects of innovation. Throughout the literature several types of classification are evident, each providing insight on understanding the innovation process. According to several researchers three of the most popular classifications are based on the distinctions between administrative and technical innovations, product and process innovations, and radical and incremental innovations (see Table 2). In essence resource based or market based (Sexton and Barrett 2003a,b)

TABLE II. INNOVATION CLASSIFICATIONS (SOURCE: SLAUGHTER, 1998; GOPALAKRISHNAN AND BIERLY, 2001; MANLEY ET AL., 2009)

Classification A	Technical	Include products, processes and technologies used to produce products or render services related to the basic work activity of an organization. Usually occur in the technical core and follow a "bottom–up" process of assimilation.
	Administrative	Pertain to organizational structures and administrative processes. Are more directly related to the management of the firm and often initiated in the administrative core and follow a top–down process of implementation.
Classification B	Product	Are outputs or services that are introduced for the benefit of customers or clients. Tend to occur with greater frequency earlier in a product's life cycle and are usually aligned with a differentiation strategy.
	Process	Are tools, devices, and knowledge in throughput technology that mediate between inputs and outputs and aid the effective implementation of a low-cost strategy?
Classification C	Radical	Produce fundamental changes in the activities of an organization and produce clear departures from existing practices. Radical innovations are rare and unpredictable in their appearance and in their impacts.
	Incremental	Is a small change based upon current knowledge and experience? Incremental innovations occur constantly.

These elements of innovation are combined in Figure 1, which is an attempt to better comprehend their range of similarity and interconnectivity. The figure highlights the existence of various classifications, types, schools or forms of innovation, as well as the complexity of the innovation process.

Figure 1. Innovation classification based on literature's different schools and forms (source: author)



From Figure 1 it can be seen that even though each type, form or school of innovation approaches the term from a different point of view the conclusion and the aim of all of them is united. They seek to solve problems in such a manner that could create the required conditions that will eventually offer the firm a sustainable competitive advantage**.**

Therefore it is important to understand the forms and types of innovation occurring if innovation is to be harnessed and managed.

Having unpacked the concept of innovation, the next section explores the need for and approach to innovation in the construction sector.

III. INNOVATION IN THE CONSTRUCTION SECTOR

Construction firms operate within an environment where rapid changes in the economy and society create demand for new types of buildings and structures. To support this, new processes of production, distribution and consumption are emerging along with new techniques for extraction of raw materials, processing, manufacture, retail and support services (Gann and Salter, 2000). As a well-established sector, construction has been shaped by local tradition, culture, and geographical factors such as availability of material and climate. However in the 21st century major changes have occurred, and continue to occur that are shifting the demand towards more functional buildings (with greater concern for user satisfaction and productivity); more sophisticated equipment (such as intelligent devices for better control of energy efficiency or indoor environment); improved working/living conditions; and more concern and respect for environmental constraints and impact (Seaden and Manseau, 2001). As such, construction firms are increasingly being challenged to successfully innovate in order to satisfy the aspirations and needs of society and clients, whilst improving their competitiveness. According to Sexton and Barrett (2003a,b), even though innovation in the construction industry is not something new, construction practitioners are now "getting to grips" with the need for, and management of, innovation as an explicit endeavour. This idea is re-enforced by Ling (2003), claiming that there are many net benefits in fostering innovation in the construction sector, especially at the project level. This makes innovation a fourth competitive dimension in construction, along with the three often cited factors of basic cost, quality and time (Newton, 1999). However, as the construction sector is a very complex arena, involving numerous agents and interactions in developing and adapting innovation (Seaden and Manseau, 2001), the challenges of studying innovation in the sector are considerable but essential, especially to understand the driving forces that trigger the implementation of innovation.

A. *Innovation driving forces and challenges within the construction sector*

It has been recognized for some time that change is needed within the construction sector see, for example, Tatum (1989), UNIDO (2013), Vinnova (2013), EU Commission (2015). Table 3 lists the driving forces for change as reported by three key sources.

TABLE III. INNOVATION DRIVING FORCES WITHIN THE CONSTRUCTION SECTOR (SOURCE: AUTHOR)

Tatum (1989)	Barrett and Sexton (2006)	Manley et al.(2008,2009)
∗ Owners struggle to regain competitiveness ∗ Privatization of public works projects ∗ Deregulation of electric generation ∗ Facilities with greater Technological sophistication ∗ Fast developing technologies that offer promise	* Supply chain management and partnering * Value and risk Management * Technical innovation	∗ Internal to the firm - Core competencies - Business strategies ∗ External to the firm - Macro context - Implementation context

It can be seen that the key drivers at firm level can be simplified into two main innovation drivers: the firm's enterprise capabilities and external environment or macro context (Manley et al., 2008, 2009). Enterprise capabilities comprise core competencies and the methods the firm uses to build and exploit them. The macro context on the other hand constitutes the firm's external environment (clients, research centres, education providers, industry associations, supply chain partners, regulators and government assistance) and the implementation context (micro environment surrounding each project).

Therefore even though innovative behaviour is identified both within and across firm and regional boundaries (Antonioli et al., 2014), the fragmented nature of the construction sector (Winch, 1998; Keast, 2006) and its highly project based operational orientation (Seadon and Manseau, 2001; Keast, 2006; Barrett et. al., 2008) hamper the sector's responsiveness to change and thus the introduction of innovative procedures.

IV. CRITICAL SUCCESS FACTORS

A critical success factor is any element that is necessary for an organization or a project to achieve its mission. The origin of success factors was developed by D. Ronald Daniel, a consultant of McKinsey Company in 1961 (Heinecke, p.57, 2011), while the process was refined and popularized by John F. Rockart (Watson, p.250, 1994). According to Phua (2004), there are differing degrees of importance to commonly suggested determinants of project success which depend on industry sector and firm origin and size. As such, CSFs are likely to be different depending on context and stakeholder perspective.

We divide CSF into three sections – innovation CSF: (i) indentificationl and within the construction sector, (ii) through the path of alliances and collaboration, and (iii) within the construction sector clusters.

A. *Identification of CSF*

The identification of CSF by the firm is essential for building the required capabilities for meeting the firm's aims and goals. Weisheng Lu et al., (2008) suggest that despite the wide acknowledgment of the CSF approach in past studies, no fixed rule has been developed for their identification. This makes working with CSF somewhat problematic. Indeed, Toor and Ogunlana (2008; 2009) highlight that the existing lists of CSF employed by different researchers are typically large and comprise several factors under various categories with little or no consensus. As such, this article seeks to categorise CSF prevalent to innovation in the construction sector from current literature before taking an empirical perspective.

According to Abetti and Stuart, innovation classifications can be incremental or radical (Abetti, 2000; Abetti and Stuart, 1988). As this article focuses on incremental innovation, the CSF that is explored are related to incremental classification. Therefore Table 4 presents a combination of several potential CSF of innovation along with their explanation.

From Table 4 it is evidence that the CSF can be simplified into two main figures: internal and external environment, a classification that comes in agreement with Table 3 findings and which will be further used during the identification of the CSF within the construction sector. Table 4 indicates that to build a strong and sustainable innovation culture and program within a firm, several foundational elements must be addressed, not in successive order but as a set of inter-related factors that should be considered simultaneously. Therefore the success of an innovation depends on several aspects which may include human-related, project-related and management-related factors, and factors related to the external environment. Such factors often have a top down approach. Meaning that the leaders and the executive personnel must understand how important innovation is. That along with their personality can significantly influence the innovative performance of their firm (Sexton and Barrett, 2003a,b).

Moving from a more general perspective of innovation to a specific construction context, researchers worldwide have repeatedly claimed that construction is a unique and complex sector where working conditions are different from other industries and business environments (Pinto and Slevin, 1988; Tatum 1989; Manley et al. 2008, 2009; Antonioli et al., 2014). Construction projects invariably involve a variety of human, budgetary, and technical variables. Additionally, they have complicated issues in dealing with numerous constraints for successful completion on time, under budget and according to

specifications. According to Toor and Ogunlana (2008; 2009) the dynamic nature of construction, the involvement of a large number of stakeholders, fragmentation of the industry, varying procurement systems, and the customized nature of every project are features which make construction projects unique. Innovation in the construction sector requires a broader knowledge of the key crucial issues for its adoption and implementation.

TABLE IV. POTENTIAL CSF OF INNOVATION (SOURCE: OAKLAND, 1989; CEDENO, 2000; BENDER ET AL., 2000; SHU-LING AND SEXTON, 2006; AKSORN, HADIKUSUMO, 2008; GORDON ET AL., 2010; MARROCU ET AL., 2013; SLEUWAEGEN AND BOIARDI, 2014)

Potential Critical Success Factors		
Top management support	=	Stability of vision – Discipline.
	=	Actively translation of ideas into actions.
	=	Effective management of change.
	=	Fast trouble-shooting capabilities in the system.
Clear goals and objectives	=	Innovation can be accomplished when realistic and achievable goals have been clearly established.
	=	Clear sense of project goals early on.
	=	Define the need and justify the product.
Deconstructing the scope	=	Breaking down to achievable parts and thus improving delegating responsibilities.
	=	Monitoring against the objectives.
	=	Identifying problems upfront and making modifications.
Project team competence	=	Team members' skills, experience, stability.
	=	Motivation and continuing participation.
	=	Adequate communication, frequent meetings.
Proven methodology	=	Vision process of project management.
	=	Learning from previous experience.
	=	Benchmarking firm's performance against successful application of innovations.
Project procurement	=	Sufficient resource allocation.
	=	Communication and coordination with the suppliers.
Interdepartmental co-operation	=	Innovation succeeds when all concerned parties realize their importance and necessity for the achievement of the goals set by each team.
	=	Shared motivation and vision.
	=	Clearly defined and allocated functions for different departments.
	=	Limited bureaucracy.
Interdepartmental communication	=	Percentage of coordination between the involved parties.
	=	Better understanding of the benefits and limitations of each of the main methods for communication (Verbal, Written, Visual).
Information storage and processing	=	Formal or informal storage of information.
	=	Standard software infrastructure and adequate use of IT.
	=	It is crucial a periodical review (effective dissemination of information).
Favourable external environment	=	Adequate support from the state.
	=	Limited bureaucracy.
	=	Favourable loans.
	=	Legislative stability.

The interest in CSF has largely been driven by research into more developed countries (Chua et al., 1999; Odusami, 2003; Shen and Liu, 2003; Iyer and Jha, 2005; Mbachu and Nkado, 2007) highlighting that the CSF vary not only by project but also by geopolitical context (Toor and Ogunlana 2008; 2009). While there is a significant volume of studies on the subject, there seems little agreement on CSF with many authors stressing the need for more work in the area.

Table 5 presents several CSF related to the construction sector based on the literature.

TABLE V. POTENTIAL CSF OF THE CONSTRUCTION SECTOR (SOURCE: PINTO AND SLEVIN, 1988; DAINTY ET AL., 2003; ODUSAMI, 2003; PHUA, 2004; BING LI ET AL., 2005; IYER AND JHA, 2005; FORTUNE AND WHITE, 2006; AHADZIE ET AL., 2008; TOOR AND OGUNLANA, 2008; 2009 WEISHENG LU ET AL., 2008; NG THOMAS ET AL., 2009; NG THOMAS AND TANG, 2010)

Potential Critical Success Factors		
Clear objective and scope	=	Definition and agreement of objectives (concerning the outcome of the project) must include a common understanding by all members involved.
	=	Definition of the scope (concerning the limits of the project) at the start of the project.
Controllable cost	=	Effective procurement, available labour force, infrastructures.
Wanted Quality	=	As seen by the customers.
	=	As seen by the public.
Wanted organizational culture	=	Positive organizational culture for effective project management.
	=	Requiring the use of facts and data to support actions at all levels of decision making.
	=	Feedback capabilities in the system.
	=	Creating accountabilities, expectations, roles, and responsibilities for the organization.
	=	Adequate project breakdown structure linked with organizational breakdown structure.
Predictable duration	=	Time taken to complete.
Effective resources control	=	Sufficient resources
	=	Availability of product and price information of labour, materials, plants and other resources.
	=	Clearly written lines of responsibility.
	=	Clear and detailed written contracts.
	=	Proper dispute resolution clauses incorporated in the contract.
Rate of delivery	=	Time taken to deliver.
Technology transfer	=	The extent to which new technology significantly improves the design and construction of a living space by decreasing installed cost, increasing installed performance and improving the construction process is applied on the project.
	=	I.T. application.
Risk containment	=	The extent to which all kinds of risk were contained or minimized.
Health and safety measures	=	Number of accidents.
	=	The extent to which employees use appropriate safety gear and equipment.
	=	Health hazard posed by the living environment.
	=	Poor material.
	=	Poor construction practices.
Environmental impact	=	Construction waste, environmental degradation and pollution on the general public.
	=	Living environment waste (rubbish, sewage, drainage).
Customer satisfaction	=	Good communication between firm and clients. Regular client consultation.
	=	Knowing what client really wants.
	=	Clear prioritization of project goals by the client.
	=	Client acceptance of plans.
Stake holders satisfaction	=	Developing positive friendly relationships with project stakeholders.
	=	Clearly defined goals and priorities of all stakeholders.
	=	Strategic alignment of project goals with stakeholders' interests.
	=	Mutual trust among project stakeholders.
Political Stability	=	Changes in laws and regulations.
	=	Bureaucracy.
Economic Stability	=	Exchange rate.
	=	Interest rate and bond/loan terms.
	=	Insurance terms.
Cultural issues	=	Specific values and norms.
	=	Staff spirit / morale.
Wanted project team	=	Competent project manager.
	=	Leader's personality.
	=	Competent team members.
	=	Building a balanced and winning team.
	=	High quality workmanship.
	=	Careful selection of subcontractors.
	=	Good relationship with suppliers.
Performance monitoring	=	Effective monitoring control.
	=	Planned close down/review/acceptance of possible failure.

B. Firm alliances and the changing nature of innovation

As globalization is leading to an increasing division of labour and economic interrelationships, cooperation is becoming the key tool to the adoption and implementation of innovation (RegCon Project, 2009). According to Sexton and Barrett (2003a,b), in an ongoing effort to bring in a new construction sector culture of: "should innovate", "can innovate", "want to innovate", a raft of government and institutionally driven initiatives have been introduced to promote the benefits of innovation (EU Commission, 2015). They were supposed to stimulate innovation capability within and between construction firms. However initiatives of this type are effective only once survival has been confidently achieved (Sexton and Barrett, 2003a,b). It is only then that firms are motivated to look towards consolidating, stabilizing and developing their innovation processes and their market and/or resource position to ensure steady-state conditions over the medium term (Barrett and Sexton, 2006, Pim Den Hertog et al., 1999, Giuliani 2003, RegCon 2009, and Pietrobelli 2015).

In this respect, different interlinked arguments have been used to explain the potential for innovation of agglomerated firms. A number of cluster policy initiatives were launched across Europe aimed at fostering existing agglomerations/clusters or creating favorable conditions for the formation of new ones. According to the Proinno web site (www.proinno-europe.eu) almost all EU member states now have cluster programmes developed at national and/or regional level, suggesting that these alliances are a key element of national and regional strategies for innovation. Thus there is a general interest in, and receptiveness towards, strategies in support of innovation through clustering (Andersson et.al 2004). Hemert et al's (2013) study provided evidence that exploring opportunities with institutions such as universities and private research establishments and various contact with competitors are important for successful innovation in SMEs. Therefore an alternative approach that could help the application of the above along with several other prerequisites for the adoption and implementation of innovation by a construction company is firms' cooperation and alliances, and thus Clustering.

C. Innovation CSF and clusters

To define a cluster is not a simple task. The concept is used for a variety of different business structures and purposes (europe-innova.eu, last entry Feb. 2014). Researchers have struggled to provide a precise definition or set of agreed principles for delimitation of clusters (Maskell, 2001; Matopoulos et al., 2005; Cortright, 2006; Sedita et al., 2012; Lazzeretti et al., 2014). This is due to multidimensionality character of clusters which pose problems of theoretical and empirical definition, as well as methodological investigation. Taking under consideration the above and baring in mind that the context of this paper is clusters within the construction sector, the term cluster will refer to a construction cluster and will mean "a geographically confined collection of firms (undertaking construction sector activities), knowledge producing agents, suppliers, customers, financial actors and state organizations based on an existing network" (Yfanti, 2015).

Tavassoli (2009) found that most literature concerning CSF and clusters focuses on one firm within the cluster; or the policy-making level; or has a viewpoint of a report rather than analytical standpoint for exploring the success factor. Thus another literature gap was revealed which our paper fills, namely, the identification of specific CSF that construction firms have to achieve, through the assistance of a cluster, for adopting and implementing innovation in their ongoing effort for competitiveness and prosperity.

Reve and Mathiesen, members of the OECD's focus group on Industrial Clusters (1994; pp.119-125, as cited in OECD 1998), summarized several CSF related with clustering. These CSF along with several others found in the literature are presented in the following table.

Table 6 presents the findings of several studies conducted in different geographic regions. Even though each case study provided different findings it is important to note that there are also similarities between the identified CSF. However, the Greek construction sector is composed mainly of SME (El.Sat) and of these, most are micro companies (RegCon). Practically nothing is written about them. According to Ter Wal Anne (2013) small and very small firms play an important role in establishing local networks but what are the CSFs that will help a micro within a cluster? The CSF are presented in Table 7.

Two of the most common, important and interlinked factors are trust and knowledge sharing. However, for competitive advantage, at least some knowledge must remain private. Hence an operational framework that would assist micro firms to safely operate within a cluster would be useful.

TABLE VI. CSF CONCERNING CLUSTERING (SOURCE: AUTHOR)

CSF	Source
High scientific level of the region's Universities.	CLIQ project (Portugal)
Job demand for graduate students and researchers.	
Technological entrepreneurship dynamics.	
Development policies from municipality leaders.	
High quality communication infrastructure.	
EU grants for R&D infrastructure investment.	
Requirements in quality in life.	
Collaboration in networking and partnership.	DTI (UK)
Knowledge creation for innovative technology.	
Choose the right (full time) Cluster Development Agent.	
Regional specialization. Ability to create a demand of specialized services and support.	Fraser and Kelly, 2010 (New Zealand)
Existence of a large pillar firm in the region. This firm could play an essential role for the beginning of their respective cluster.	
Existence of academic activities and specialized educational programmes designed to meet the needs of the region.	
Presence of academic institutions in the region feeds the area with deep and highly skilled local workforce.	
Existence of specific standards within the sectors area.	
Time. Often, successful clusters date back to relative advantages or disadvantages which were present centuries ago. In any case, it takes time to develop industrial base, customer relations, and brand names.	Reve, Mathiesen, (Finland) (as cited in OECD '98)
Critical mass. An industry has to be fairly big before economies of scale and scope can be fully utilised.	
Entrepreneurs and dedicated people. Most dynamic clusters contain stories of entrepreneurs who significantly influenced the industry.	
Demanding international customers. Cluster studies show that demanding customers are the key source of competitive advantage.	
Rivalry and co-operation. Rival companies are the main feature of a cluster. Lucrative companies, however, often co-operate even with their main competitors when necessary and mutually beneficial.	
Advanced suppliers. Competitive subcontractors can be a major source of innovations and allow firms to concentrate on their core competencies.	
Flexible organisation and management. Organisational flexibility is needed especially during periods of excessive turmoil.	
Continuous knowledge development. There is no saturation level to cluster innovativeness. Existing competitive strength will be lost if the upgrading process stops.	
National pride. Industries that are nationally appreciated attract the best talent in the country.	
Strong inter-firms linkages in cluster (e.g. marketing, distribution, production, procurement of materials, training of workers).	Tambunan, (Indonesia)
External networks between the cluster and institutions outside the cluster especially large firms.	

TABLE VII. CSF FOR A MICRO FIRM (SOURCE: AUTHOR)

CSF	Source Study
Engagement and commitment by the owner.	Based on the NEPIC model (UK)
Ability to be engaged through a trusted intermediary body.	
Ability to interact with local demand. This interaction will provide the basis for translating innovation into commercial success.	Fraser and Kelly, 2010 (New Zealand)
Percentage of reliance to another person to both lead and manage the firm.	
Ability to diffuse a productive and in the same time exceptive to innovation atmosphere within the firm.	
Quality of the human resources, as a balanced mix of skills is required: general and sector-specific.	Workshop on Clusters, 2005 Beirut; Viehoever 2012: pp.44

V. METHODOLOGY

A. Research within The Greek Context

The Greek construction sector has witnessed significant reduction in the revenue earned from projects making innovation critical. Most Greek construction companies are classified as micro since, according to the Foundation for Economic and Industrial Research 2008 report(IOBE) of the 98,926 companies operating in the domestic construction sector 97.69% employ less than five employees and 92.31% have a turnover of less than 150,000 euros. However, government initiatives seem to benefit the wealthier enterprises not micro-companies, making their daily struggle for survival difficult and access to the benefits from high added values of exploitation of new knowledge and innovation creates impossible.

The research focused on this context and within Crete. As Crete is Greece's biggest island it provides a fair indicator of Greece as a whole and has all the necessary human and material infrastructure, state representation, academic institutes and above all the Greek culture.

B. Research Framework

As the construction sector draws on a wide variety of subject areas, such as engineering, management, human and social sciences, this research used a case study strategy with a mixed method approach involving a specific sector (the construction sector) located within a specific national context (Greece, Crete). Data collection was both quantitative (questionnaires) and qualitative (in-depth interviews).

In considering the issue of CSF for micro companies in innovation the existing research formed the basis of CSF to test. This approach follows broadly from the information in table 3 and the views of Harty (2005).

The target subjects were top management in companies based on the NACE 1.1 sector classification and the specificities of the Greek legislation framework concerning construction. A pilot questionnaire was sent prior to the main research. It was based on Table 8 and divided in the three sections: project, manager/owner, and the state. The duration of the pilot study was one month while the main study lasted four months (three months for the questionnaires and one month for the interviews). The time period of the research was the second semester of 2014. The questionnaires sampling method was census (420 companies) and the responses (92 usable responses) were collected both via "survey monkey" and fax (providing a response rate of nearly 22%), while the ten interviewed firms were selected as key players. Questionnaire's internal validity was assessed by the calculation of Cronbach's Alpha. The interviews followed a general guide and were open-ended. The questions asked were divided into three levels as shown in figure 2.

To focus the discussion, three main categories of problems for the Greek construction sector were identified (IOBE, 2008) and used as a stimulus.

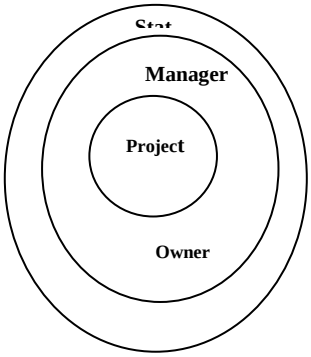


Figure 2. CSF' sections (source: author)

1) The actions that the state has to make (the institutional framework governing the production of public and private).
2) The actions to be implemented by the companies themselves (projects and the competitive conditions in the Greek construction market).
3) The owner of a micro-company who plays a pivotal role in the company's focus and ultimate success (Kelliher and Reinl, 2009).

Table 8 shows the CSF from literature (combining tables 4-7) divided into the three levels from figure 2.

The last four columns refer to factors referenced in tables 4-7. It will be noticed that there is little consistency. The section concerning the State contains four (4) factors, the section concerning Manager/Owner contains six (6) factors and the section concerning the Project contains eight (8) factors. Hence the number of factors increases as the target is approached. As the number of factors in each section was based on the literature review this observation strengthens the choice of a "target" based approach, justifying the configuration of fig. 2.

VI. FINDINGS AND DISCUSSION

The findings confirmed that the construction sector in Crete seems to be dominated by micro firms. This is in accordance with both IOBE (2008) indications for the whole of Greece and in accordance with Wharton and Payne (2003) statement that "the vast majority of EU construction firms (90%) are small to medium sized; of these, 93% are micro firms with fewer than ten employees."

Table 9 shows the survey results for the category "projects". There was agreement between the literature and this study for the first two categories, namely

a) That there was a need for further training for both their personnel and themselves and
b) The existence of seminars that will keep not only the owners but also their personnel updated concerning new materials, methods and tools.

There was less agreement for the rest of the factors as the priority orders have changed and more CSF have been added.

TABLE VIII. CSF RESEARCH FRAMEWORK (SOURCE: AUTHOR)

Section		FACTORS	TABLES			
			5	6	7	8
PROJECT	a	Early definition of project's (clear) goals.	□	□		
	b	Define the need (problem) and justify the change.	□	□	□	
	c	Existence of the right team (skills, motivation, experience).	□	□	□	□
	d	Effective procurement.	□		□	□
	e	Team's (subcontractors') ability to cooperate, trust and communicate.	□	□	□	
	f	Existence of a framework for information storage and sharing.	□	□	□	
	g	Level of accepted quality.		□	□	
	h	Risk containment (contracts, responsibilities, accidents).		□		
MANAGER / OWNER	a	Stability of vision and commitment.	□			□
	b	Ability to manage change.	□		□	□
	c	Ability for resource allocation.	□	□	□	□
	d	Ability for performance monitoring.		□		
	e	Technological and knowledge dynamics.		□	□	
	f	Ability to trust.	□		□	□
STATE	a	Legislative stability.	□	□		
	b	Economic support (loans, taxation, insurance).	□	□	□	
	c	Creation of a platform for dialogue and cooperation between industry and academia.			□	
	d	Creation of regional specialization.			□	

TABLE IX. CSF RELATED TO MICRO AREA NEW RANKING (SOURCE: AUTHOR)

PROJECT		
CSF from literature	***Rank***	***Research CSF micro companies***
Framework for information storage and sharing	1	Quality of human resource
Create right project team	2	Create right project team
Risk management	3	Effective procurement
Effective procurement	4	Risk management
Define the need	5	Early goal definition
Communicate and trust	6	Embrace change
Early goal definition	7	Selective information sharing
Level of accepted quality	8	Share risks within alliances
	9	Cooperation within alliances

The next section of the questionnaire related to the category "owner/manager". According to the findings presented in Table 10, CSF seem to follow the same pattern both in theory and practice, with the exception of the first factor from the empirical data "access to finance" which was mentioned by all the respondents in the open question of the questionnaire.

TABLE X. CSF RELATED TO MEZZO AREA NEW RANKING (SOURCE: AUTHOR)

Management		
CSF from literature	***Rank***	***Research CSF micro companies***
Resource allocation	1	Access to finance
Technology and knowledge update	2	Resource allocation
Vision and commitment	3	Technology and knowledge update
Change management	4	Performance monitoring
Performance monitoring	5	Committed leadership
Trust between partners	6	Importance of innovation
	7	Trust between partners

As micro firms are influenced by their own internal culture (Becherer et al., 2001) their success heavily depends on the human capital of their owner or manager (Jones et al, 2007). Manager/Owners ability to stay focused on goals and to persuade their personnel to follow them in this difficult journey was also mentioned during in-depth interviews. Performance monitoring is also important and strongly linked with leadership's commitment to the project's goals. The fact that they consider it significant to be kept up to date with new technologies and knowledge, agrees with Caerteling et al. (2006).

The last section of the questionnaire considered "State" (figure 2), as governments have a key role to play not only in managing knowledge in their ministries and agencies but also in improving the acquisition and application of knowledge on an economy-wide base and in providing both economic and legislative stability to all sectors of the economy. Table 11 shows the perception of CSF at state level.

TABLE XI. CSF RELATED TO MACRO AREA NEW RANKING (SOURCE: AUTHOR)

State		
CSF from literature	***Rank***	***Research CSF micro companies***
Industry/academia links	1	Stable legislation
Regional specialisations	2	Economic support
Economic support	3	Supporting infrastructure
Supporting infrastructure	4	Company branding
Stable legislation.	5	Industry/academia links

Comparing theory on the left with empirical data findings on the right (figure 5), it can be observed that the two rankings are completely opposite. Cretan construction micro firms consider legislative stability more important than State's economic support, with the creation of a supporting infrastructure and a trade mark to follow. The frequent changes within the legislative framework of the Greek construction sector seem to create a climate of insecurity which strongly influences the firms (Phua, 2004). During the interviews the participants expressed strongly that they live with the constant fear that they will wake up one day and a change to a law will turn everything upside down in their planning, overbalancing their targets and goals and potentially resulting in their economic demise. As for State's involvement with sector's economic support, even though they believe that it is an important factor according, they also believe that the State will never truly support them, therefore there is no point in anticipating it.

Lastly, both questionnaires and interviews found that academic/research institutions were last on their list of priorities. Even though Crete is a major centre for education and research, they still seem to lack a connection with industry.

VII. CONCLUSIONS

There seems to be general agreement that construction enterprises need to innovate if they are to compete successfully. To this end, several definitions of innovation were presented in order to arrive at the one most relevant for the construction sector. For clarity, the many definitions of innovation were tabulated (figure 1). It was seen that the more current definitions lean towards consistent yet incremental improvement.

Clearly the construction sector must follow customers' requirements. They are increasingly insistent on changes in technology or dependent on environmental or safety regulations but it is becoming increasingly difficult not only for individual companies to produce all the relevant knowledge themselves but also for them to translate new knowledge into innovative products or processes (OECD, 1998; RegCon, 2009; Antonioli et al., 2014). It is no surprise, therefore, that the analysis of current literature identified "alliances and cooperation" as key terms. This article suggests a clustering approach for micro firms could offer a means to attain the CSF for the adoption and implementation of innovation.

Although Greece is an EU member with an advanced economy, there are some peculiarities that the Greek construction sector presents. One of them is the very small size of the construction companies: a condition reinforced by the economic crisis and the complicated legislation systems that often change and at short notice.

The CSF that was identified in the literature were reclassified within a framework for Crete micro-companies in Figure 2. This was presented in Figures 3, 4 and 5 where similarities and differences were shown, highlighting that findings based on work with larger companies do not necessarily reflect micro-companies.

The differences seem to point to a need to improve management of micro-companies: internally as regards processes and externally as regards ability to access resources and information.

This paper has highlighted factors that should interest policy makers at all levels, who would wish to assist micro construction firms to improve their performance, and presented a systematic analysis of a micro construction firm's CSF towards innovation, provides significant information and

knowledge to construction firm's managers/owners and practitioners alike. We believe using the CSF as a tool could increase the micro firms chances of survival through difficult economic times.

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